Insolation

Syllabus

Insolation: *Meaning of insolation and terrestrial radiation.*

Factors affecting temperature: latitude, altitude, distance from the sea, slope of land, winds and ocean currents.

The sun continuously radiates heat and light energy in all the directions. It is known as *solar radiation*. The flow of energy from the sun to the earth and then into space is a complex process. This involves energy transmission, storage and transport. Energy transmission is in the form of radiation; whereas energy storage and transport occurs in the form of heat in the atmosphere, hydrosphere and lithosphere. Solar radiation is the only primary source of light and heat on the earth. The earth receives its heat from solar radiation which is a tiny fraction of the radiated energy of the sun.

TYPES OF RADIATION

The sun's radiation is made up of three parts—*white light* (that we see), *infrared* radiation and *ultraviolet* radiation. The sun also emits atomic particles, called *'Solar Wind'*, into space. Most of the particles of solar wind are charged *electrons*. These electrons affect the earth's magnetic field. The energy needed for all movement and change on the earth is provided by the sun.

Insolation: The amount of solar energy received by the earth is called *insolation*. The sun's energy is dissipated and scattered before it reaches the earth. Only one part out of two billion parts reaches the earth.

The sun's energy reaches the earth as short wave rays. Out of the total 100% solar energy only 51% reaches the earth, 35% is reflected back into space and only 14% is absorbed by the atmospheric layers including ozone during insolation.

(b) *Terrestrial Radiation:* Solar radiation (insolation) strikes the surface of the earth. The surface of the earth radiates this heat back into the atmosphere in the form of long waves. The heat radiated by the earth in the form of long waves is called *Terrestrial Radiation*.

There exists a state of equilibrium on earth between incoming insolation from the sun and the outgoing terrestrial radiation from the earth, known as ***Heat Balance***. When both incoming radiation and outgoing radiation are balanced, it is called *heat budget*.

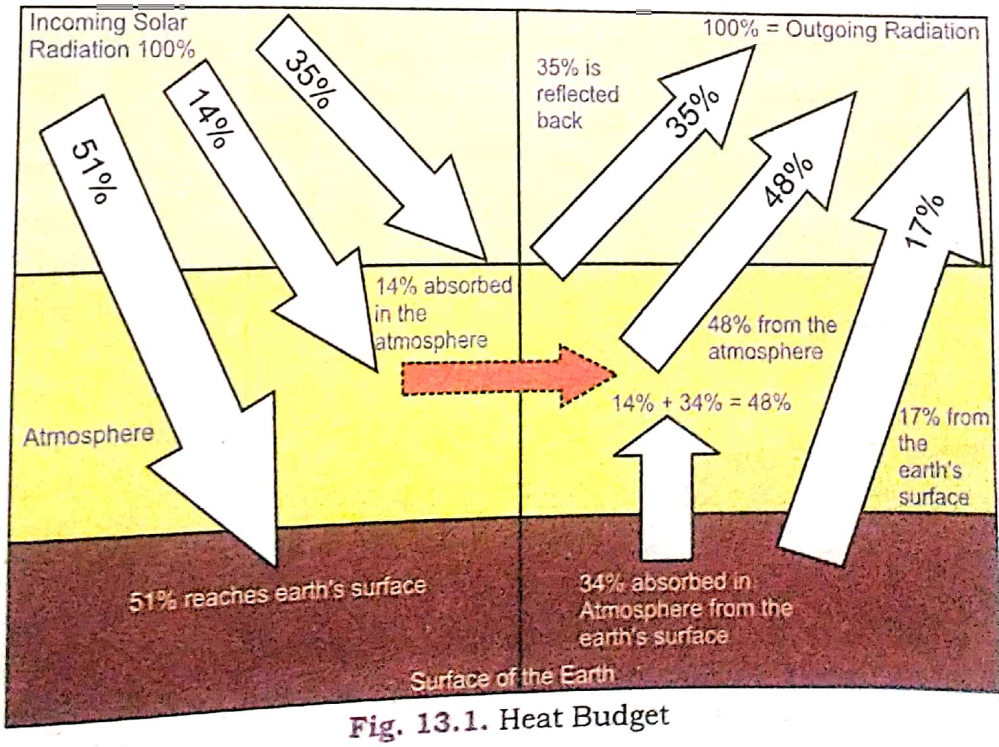

Fig. 13.1. Heat Budget

Heat balance is a worldwide average balance as low latitude areas receive more radiation than they lose, while the opposite occurs near the Poles.

How is the Balance Achieved?

The balance of the heat budget is important for life to survive on the earth. Since the earth rotates on its axis, the sun's rays do not warm all parts of the earth equally. This sets off several processes into motion and has an impact on the earth's heat distribution. The heat radiated by the earth's surface warms the layers of air above it by direct contact. This is called *conduction*. The circulation of air and water in oceans causes transfer of heat from one medium to another or from one level to another. This transfer of heat by circulatory movement is called *convection* (Fig.13.2).

Convection currents in the atmosphere cause sea breeze. During the day, air over land becomes warmer and rises. Cool air from oceans moves in to take its place. At night the opposite of this happens. This is because land surface gets cooled more quickly than the ocean surface and land breezes are caused.

The atmosphere absorbs 34 units of the earth's radiation; but it absorbs only 14 units of the sun's incoming radiation. Thus, the atmosphere is heated more by terrestrial radiation given out by the earth than by the incoming insolation from the sun. The atmosphere acts like a *blanket.*

(i) At night, the atmosphere acts like a greenhouse and keeps the earth's surface warm by preventing the terrestrial radiation from escaping into space.

(ii) During the day, the atmosphere absorbs 14% of insolation and thus regulates temperature on earth.

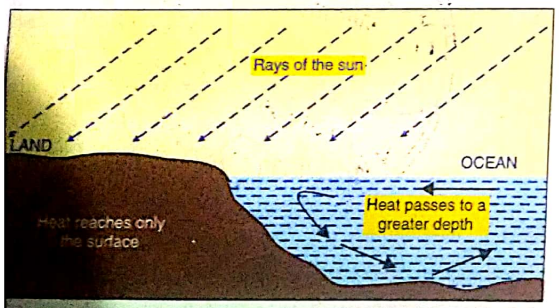

Fig. 13.2. Difference in heating of land (Conduction) and heating of a sea (Convection)

Thus, the atmosphere prevents extremes of temperatures. The earth would become very hot during the day and very cold at night, if the atmosphere would not be there.

FACTORS AFFECTING THE DISTRIBUTION OF TEMPERATURE

Distribution of temperature over the earth is not uniform. The temperature of the atmosphere of a place depends upon a number of factors, chiefly the following — winds and ocean currents, latitude, distance from the sea, altitude and slope of the land.

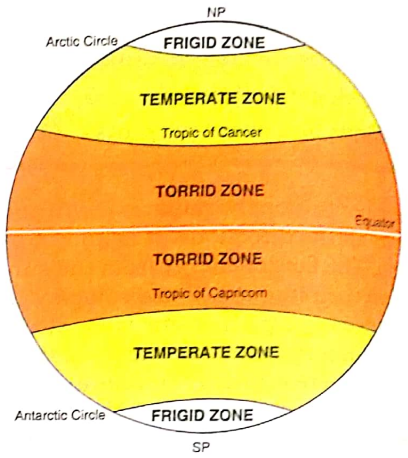

Fig. 13.3. Heat Zones

1. Latitude

Temperature depends on the latitude of a place.

(i) Temperature decreases with increase in latitude on either side of the Equator due to spherical shape of the earth and its annual revolution around the sun.

(ii) Sun's rays strike the earth at varying angles of incidence owing to spherical shape of the earth and its inclination on its axis. Oblique or slanting rays not only travel a longer distance, but also heat a larger area. Thus, they have less heating power (Fig. 13.2). Midday sun is almost overhead within the tropics but at oblique angles outside the tropics.

The above two factors indicate that higher the latitude the colder is the place. On this basis, the earth is divided into 5 temperature zones. These are: the Torrid Zone between the

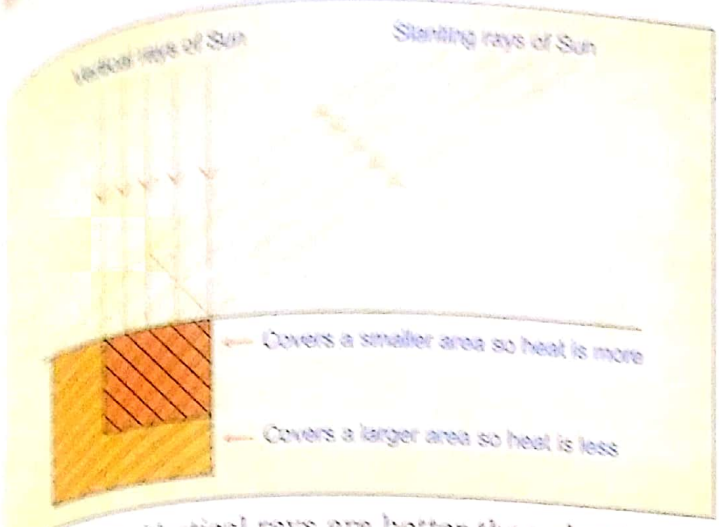

Fig. 13.4. Vertical rays are hotter than slanting

tropics of Cancer and Capricorn; the North Temperate Zone and the South Temperate Zone and the two Frigid Zones.

The sun's rays which fall over the Torrid Zone travel shorter distance and heat up a smaller surface area leading to higher temperature. Beyond the Torrid Zone sun's rays travel longer distance. This is because of inclined axis and revolution of the earth on its axis. Much of the heat is absorbed by clouds and water vapour or reflected back by dust particles. The sun's rays fall in a slanting position and heat up a larger area. Beyond the Torrid Zone temperature goes on falling. There are however other factors as well that influence the climate and air temperature.

2. Altitude

The height of a place above the mean sea level is known as its altitude. Temperature of the atmosphere and altitude are interrelated. The higher the altitude, the lower the temperature. This is because of the following factors:

(i) Air is cooler at higher altitudes than on the earth's surface. The main reason for decrease of temperature with height is that the atmosphere is heated from below, more by terrestrial radiation than by incoming solar radiation.

(ii) Air on the surface of the earth is denser and contains more carbon dioxide, water vapour and other gases. Hence, its heat absorption capacity is more in the lower layers than in upper layers where its density is less.

The rate of decrease of temperature with height is about 6°C per km above the sea level. This means that on climbing every 166 metres, there is a fall of 1°C in temperature. It is known as

Normal Lapse Rate. It is usually more in summer than in winter. This explains why it is cooler at the top of a mountain than at the bottom or why hill resorts in summer in tropical countries have a pleasant climate than the plains.

3. Distance from the Sea

Sun's rays pass through water to a great depth. Water is mobile and the warm water mixes easily with the cold water. Because of these reasons, the water is neither heated nor cooled quickly. However, the sun's rays heat a piece of land more rapidly because unlike water, the heat obtained by the area remains confined to that area and does not mix with other areas of land. Hence, the land gets heated or cooled more quickly than the water. Thus, during the day, the land is hotter than the sea. The hot air over the land becomes lighter and goes upwards. This creates a low pressure area over the land.

The air above the sea is cooler during this time. When this air blows towards the low pressure area over the land, it lowers the temperature of the air on land. Such cool breeze that blows over the earth is known as *Sea Breeze.* This sea breeze cools the coastal regions. In the night, the situation is the reverse. The sea remains warmer than the land, so the breeze blows from land to sea. This *land breeze* makes the sea cooler. Thus, the interchange of breeze maintains the heat balance. The areas, close to the sea have lower daily and annual

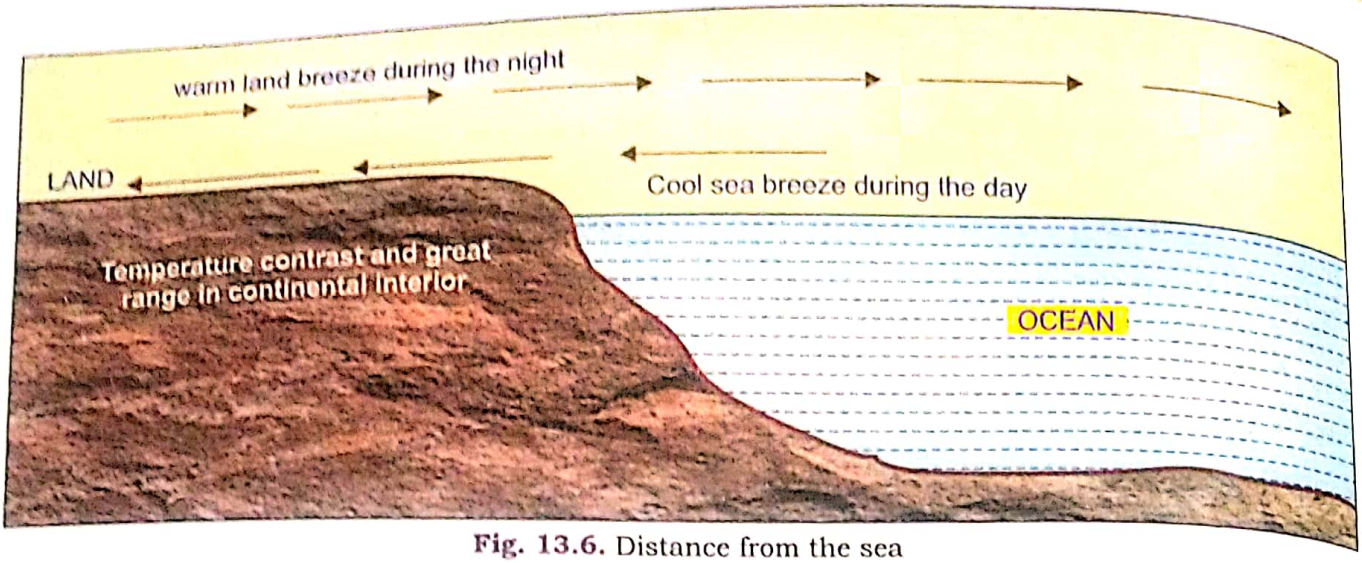

Fig. 13.6. Distance from the sea

ranges of temperatures and enjoy a moderate climate than the areas lying in the interior.

4. Slope of the Land

Slope of the land influences the temperature of a place. For example, an area with a steep slope experiences a more rapid change in temperature than a gentle one. That is why, mountain range with an east-west alignment like the Alps have a higher temperature on the south-facing sunny slope than the north-facing sheltered slope.

Similarly, temperature may be lower in the valley than higher up the slopes. It happens on calm, cold winter nights, when the sky is clear and the air very dry. Due to these conditions, the heat from the earth's surface escapes rapidly back into space, making the upper slopes warmer. The cold is further increased by the sinking of the cool air from the mountain sides. In this way, there is a reversal in the vertical distribution of temperature. In this case, temperature decreases down in the valleys. This is known as the *Inversion of Temperature.*

5. Winds and Ocean Currents

The landmass gets heated and cooled fast. The water mass, i.e., seas and oceans retain heat for a longer period. Equatorial waters remain hot and give rise to warm currents, while the polar waters are cold. The winds from the oceans and ocean currents transport heat or cold. Warm currents move from Equatorial to polar latitudes. They transport warm water to cooler regions. Currents which flow from higher Polar latitudes to lower latitudes in Equatorial regions carry cool water to warm regions. In this way, warm currents along the coast make the coastal areas warmer and cold currents make them cooler than usual.

We have already learnt that the warm North Atlantic Drift raises the winter temperature of North-West Europe, especially those of the British Isles and Norway. Due to the influence of the Warm North Atlantic Drift, the port of Bergen (about 60°N) in Norway remains open during the winter season, while the ports on the north-east coast of Canada, located in the same latitudes, remain frozen for several months because of the influence of the cold Labrador Current.

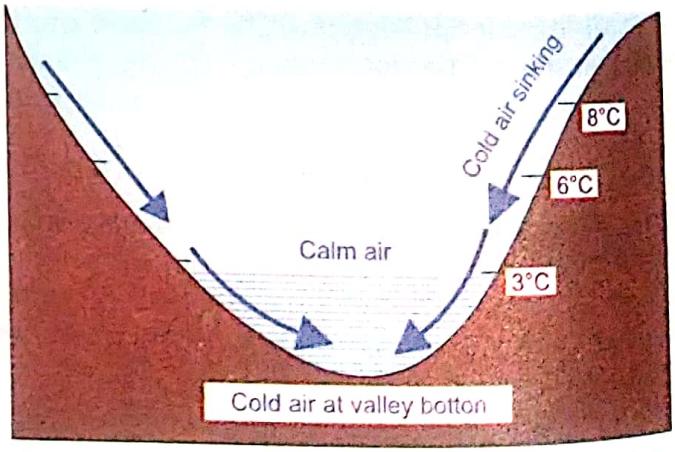

Fig. 13.7. Temperature inversion at valley bottom on a calm still night